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Ottawa, Canada  
K1A 0C9

(21) (A1)

2,082,700

(22)

1992/11/12

(43)

1994/05/13

5,085,0/65

(51) INTL.CL.<sup>5</sup> B29C-045/30

(19) (CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) Injection Molding Torpedo with Diagonal Melt Bore

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(73) Same as inventor

(57) 12 Claims

Notice: This application is as filed and may therefore contain an  
incomplete specification.

**Canada**

CCA 3254 (10-92) 41 7530-21-936-3254

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ABSTRACT OF THE DISCLOSURE

An injection molding torpedo having a main portion and a forward portion with a conical surface having a forward tip. The main portion is received in a seat in the forward end of a nozzle with the forward tip aligned with the gate. The torpedo has a melt bore with a central rear portion and a diagonal portion extending to the conical surface. The main portion has an outer surface which fits in contact with the surrounding heated nozzle and the configuration of the melt bore provides the torpedo with a greater area of highly conductive metal. This allows the temperature in the tip to respond rapidly to thermal changes during the injection cycle so cycle time can be reduced.

INJECTION MOLDING TORPEDO WITH  
DIAGONAL MELT BORE

BACKGROUND OF THE INVENTION

This invention relates generally to injection molding and more particularly to a torpedo having a tip and a diagonally extending melt bore to be mounted at the forward end of an injection molding nozzle.

5           Seating a torpedo having a conical surface leading to a forward tip in a heated nozzle to control the build up of excessive friction heat in the area of the gate is well known as one type of hot tip gating. The forward end of the nozzle is separated from the cavity plate through which the gate extends by an insulative air space  
10           which usually is bridged to prevent the melt escaping into the air space. In one previous type seen in the applicant's U.S. patent number 4,450,999 which issued May 29, 1984, the torpedo has a central shaft with a forward

tip which is connected by a number of radial ribs to an outer collar which bridges the insulative air space. The melt flows through a number of channels extending between the ribs around the central shaft to the gate. In another previous type seen in the applicant's U.S. patent number 5,028,227 which issued July 2, 1991, the ribs extend inwardly from a mounting ring or flange which is secured in place by a gate insert which bridges the air space between the forward end of the nozzle and the cavity plate. A similar arrangement is shown in the applicant's Canadian patent application serial number filed September 22, 1992 entitled "Injection Molding Nozzle with Thermocouple Receiving Torpedo", but in that case the outer collar is retained in place by a cylindrical nozzle seal and there is only a single rib extending in to the central shaft. All of these previous torpedoes have a central shaft held in place by one or more radial ribs. The metal ribs necessarily have a thin cross-section which restricts heat transfer through them. Also, the previous torpedoes having a ribbed configuration are relatively costly to manufacture. The applicant's U.S. patent number 4,583,284 which issued April 22, 1986 shows a nozzle having a tip and a melt bore having a diagonal portion, but there is no provision for a replaceable torpedo.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to at least partially overcome the disadvantages of the prior art by providing a replaceable torpedo which is economical to make and has a tip with a rapid response to temperature changes.

To this end, in one of its aspects, the invention provides an injection molding torpedo to be mounted at the forward end of a nozzle, the nozzle having a melt passage with an inner surface and a predetermined diameter extending therethrough in alignment with a gate, the forward end of the nozzle having a seat with a forward facing shoulder and an inner surface extending around the melt passage to receive the torpedo, the torpedo comprising a main portion having a rear end, a forward portion extending from the main portion, and a melt bore extending therethrough, the main portion having a rearward facing surface to abut against the forward facing shoulder in the nozzle to seat the torpedo in the seat in the nozzle, the forward portion having a conical surface with a forward tip to extend centrally in alignment with the gate and provide a space around the conical surface leading to the gate, the melt bore extending from the rear end with a diagonal portion extending to the conical surface to convey melt from the melt passage in the nozzle to the space around the

conical surface leading to the gate.

Further objects and advantages of the invention will appear from the following description taken together with the accompanying drawings.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a sectional view of a portion of an injection molding system showing a torpedo according to a first preferred embodiment of the invention,

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Figure 2 is an exploded isometric view showing the torpedo and nozzle seal in position for insertion in the nozzle seen in Figure 1,

Figure 3 is a sectional view showing the torpedo retained in position by a gate insert, and

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Figure 4 is a sectional view showing a torpedo according to a second preferred embodiment of the invention.

#### DETAILED DESCRIPTION OF THE INVENTION

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Reference is first made to Figures 1 and 2 which show a portion of a multi-cavity injection molding system having several nozzles 10 to convey pressurized plastic melt to respective gates 12 leading to different cavities 14 in the mold 16. The mold 16 includes a cavity plate 18 and a back plate 20 which is secured to the cavity plate 18

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by screws 22. Other molding configurations may have a variety of other plates or parts, depending on the application. The mold 16 is cooled by pumping cooling water through cooling conduits 24 extending in the cavity plate 18 and the back plate 20. An electrically heated steel melt distribution manifold 26 is mounted between the cavity plate 18 and the back plate 20 by a central locating ring 28 and insulative and resilient spacer members 30. The melt distribution manifold 26 has a cylindrical inlet portion 32 and is heated by an integral electrical heating element 34. An insulative air space 36 is provided between the heated manifold 26 and the surrounding cooled cavity plate 18 and back plate 20. A melt passage 38 having a common inlet 39 in the inlet portion 32 of the manifold 26 branches outwardly in the manifold 26 and extends through each nozzle 10 to the gates 12.

Each nozzle 10 has a forward end 40 and a rear end 42 which abuts against the melt distribution manifold 26. An electrical heating element 44 extends helically around the centrally extending melt passage 38 and has an external terminal 48 to which power leads 50 are connected. The nozzle 10 is received in a well 52 in the cavity plate 18 and is located in this position by having a circular insulation flange 54 which is seated against a matching shoulder 56 in the well 52 in the cavity plate 18. The

nozzle 10 has an enlarged portion 58 adjacent its forward end 40 with a bore 60 into which a thermocouple element 62 extends to monitor the operating temperature adjacent the forward end 40 of the nozzle 10. The central melt passage 38 which extends from the manifold 26 through each nozzle 10 is aligned with the gate 12 extending through the cavity plate 18 to the cavity 14. The central melt passage 38 through the nozzle 10 has an inner surface 64 with a predetermined diameter. The forward end 40 of the nozzle 10 has a seat 66 with a forward facing shoulder 68 and a cylindrical inner surface 70 in which a torpedo 72 according to the invention is mounted.

In this embodiment, each torpedo 72 has a main portion 74 with an outer surface 76 and a forward portion 78 with a conical surface 80 extending to a forward tip 82. The outer surface 76 has a circular mounting flange 84 extending outwardly around it. The torpedo 72 is accurately seated in position with the forward tip 82 in alignment with the gate 12 by the mounting flange 84 being secured in the seat 66 by a hollow nozzle seal 86 which is seated against the cavity plate 18 to extend around the gate 12. The forward end 40 of the heated nozzle 10 is separated from the cooled cavity plate 18 by an insulative air space 88, and in this embodiment the nozzle seal 86 bridges the air space 88 to prevent pressurized melt



leaking into it. The manifold 26, nozzles 10, torpedoes 72, and nozzle seals 86 are securely retained in this position against the melt injection pressure by force from the screws 22 which is applied to the manifold 26 through the spacer members 30.

The nozzle seal 86 has a circular removal flange 92 which extends outwardly into the air space 88 and is spaced from the forward end 40 of the nozzle 10 to provide for removal of the nozzle seal 86 by prying it out with a screwdriver or other similar tool. The circular mounting flange 84 has a rearward facing surface 94 which abuts against the forward facing shoulder 68 of the seat 66. The outer surface 76 of the main portion 74 of the torpedo 72 has a first cylindrical portion 96 which extends rearwardly from the circular mounting flange 84 to the rear end 98 and fits in contact with the inner surface 64 of the melt passage 38 through the nozzle 10. The outer surface 76 of the main portion 74 of the torpedo 72 also has a second cylindrical portion 100 which extends forwardly from the mounting flange 84 to the conical surface 80 and fits in contact with the surrounding nozzle seal 86 which in turn fits in contact with the inner surface 70 of the seat 66.

Each torpedo 72 also has a melt bore 102 with a rear portion 104 which extends centrally from the rear end 98 and a diagonal portion 106 which extends from the rear

portion 104 to the conical surface 80. The rear portion 104 tapers inwardly from a diameter at the rear end 98 which is equal in diameter to and in alignment with the melt passage 38 through the nozzle 10 to avoid turbulence in the melt flow. The melt from the melt passage 38 flows through the melt bore 102 in the torpedo into a space 108 around the conical surface 80 which leads to the gate 12. The torpedo is made of a highly heat conductive metal such as a beryllium copper alloy or molybdenum. The configuration of the torpedo 72 and the extent of contact with the surrounding nozzle 10 and nozzle seal 86 provides the forward tip 82 with a rapid response to temperature changes during the injection cycle.

In use, the injection molding system is assembled as shown in Figure 1. While only a single cavity 14 has been shown for ease of illustration, it will be appreciated that the melt distribution manifold 26 normally has many more melt passage branches extending to numerous cavities 14 depending on the application. Electrical power is applied to the heating element 34 in the manifold 26 and to the heating elements 44 in the nozzles 10 to heat them to a predetermined operating temperature. Pressurized melt from a molding machine (not shown) is then injected into the melt passage 38 through the common inlet 39 according to a predetermined cycle in a conventional manner. The

pressurized melt flows through each nozzle 10 and the melt bore 102 of the aligned torpedo 72 into the space 108 around the conical surface 80 and then through the aligned gate 12 to fill the respective cavity 14. After the cavities 14 are filled, injection pressure is held momentarily to pack and then released. After a short cooling period, the mold is opened to eject the molded products. After ejection, the mold is closed and injection pressure is reapplied to refill the cavities 14. This cycle is continuously repeated with a frequency dependent on the size and shape of the cavities 14 and the type of material being molded. For initial start-up of the molding process, heat from the heating element 44 in each nozzle 10 is conducted forwardly through the torpedo 72 to the tip 82 aligned with the gate 12. During injection, the torpedo 72 conducts excess heat which is generated by friction of the melt flowing through the constricted area of the gate 12 rearwardly to avoid stringing and drooling of the melt when the mold opens for ejection. After the melt has stopped flowing, solidification in the gate is enhanced by the removal of the excess friction heat through the torpedo 72. In many applications, ambient heat in the melt from the machine cylinder and friction heat is sufficient to keep the system functioning after start-up. This heat prevents the melt completely freezing in the area of the gate 12 and

forming a solid plug which would interfere with injection when injection pressure is reapplied after the mold is closed. The configuration of the torpedo 72 according to the invention does not have restricted cross-sections of the conductive metal through which the heat must flow and there are large areas of contact between the torpedo 72 and the surrounding nozzle 10 and nozzle seal 86. This provides the forward tip 82 with a rapid response to these changes in temperature during the injection cycle and thus cycle time can be reduced.

Reference is now made to Figures 3 and 4 to describe other applications and embodiments of the invention. As many of the elements are the same as those described above, common elements are described and illustrated using the same reference numerals. Referring first to Figure 3, the configuration of the torpedo 72 is the same as that described above, but it is secured in place in the seat 66 in the forward end 40 of the nozzle 10 by a hollow gate insert 110 rather than by a nozzle seal. The gate insert 110 has a tapered forward portion 112 seated in a tapered opening 114 which extends through the cavity plate 18 to the cavity 14. The gate insert 110 has a cylindrical rear portion 116 which extends into the seat 66 in the forward end 40 of the nozzle 10 and fits in contact with the surrounding inner surface 70 of the seat.

The torpedo 72 is retained in place by the circular mounting flange 84 being secured between the forward facing shoulder 68 of the seat 66 and the rear portion 116 of the gate insert 110. The gate insert 110 bridges the air space 88 between the forward end 40 of the nozzle 10 and the cavity plate 18 and also has a circular removal flange 118. The first cylindrical portion 96 of the outer surface 76 of the main portion 74 of the torpedo 72 fits in contact with the inner surface 64 of the melt passage 38 through the nozzle 10, and the second cylindrical portion 100 of the outer surface 76 fits in contact with the surrounding gate insert 110. Thus, in use, the tip 82 of the torpedo 72 will have the same rapid response to thermal requirements during the injection cycle described above.

Another embodiment of the invention is shown in Figure 4 in which the rear end 98 of the main portion 74 of the torpedo 72 abuts against the forward facing shoulder 68 of the seat 66. The first cylindrical portion 96 of the outer surface 76 which extends from the rear end 98 fits in contact with the inner surface 70 of the seat 66. The second cylindrical portion 100 is smaller in diameter than the first cylindrical portion 96 and extends forwardly from a shoulder 120 which extends inwardly from the first cylindrical portion 96. A nozzle seal 86 as described above abuts against this shoulder 120 and the second

5 cylindrical portion 96 fits in contact with the surrounding nozzle seal 86. Of course, the melt bore 102 through the torpedo also has the central rear portion 104 and the diagonal portion 106 extending to the conical surface 80 which is relatively easy to machine and provides the torpedo 72 with a greater area of highly conductive metal for heat transfer to and from the forward tip 82.

10 While the description of the torpedo 72 has been given with respect to preferred embodiments, it will be evident that various other modifications are possible without departing from the scope of the invention as understood by those skilled in the art and as defined in the following claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An injection molding torpedo to be mounted at the forward end of a nozzle, the nozzle having a melt passage with an inner surface and a predetermined diameter extending therethrough in alignment with a gate, the forward end of the nozzle having a seat with a forward facing shoulder and an inner surface extending around the melt passage to receive the torpedo, the torpedo comprising a main portion having a rear end, a forward portion extending from the main portion, and a melt bore extending therethrough, the main portion having a rearward facing surface to abut against the forward facing shoulder in the nozzle to seat the torpedo in the seat in the nozzle, the forward portion having a conical surface with a forward tip to extend centrally in alignment with the gate and provide a space around the conical surface leading to the gate, the melt bore extending from the rear end with a diagonal portion extending to the conical surface to convey melt from the melt passage in the nozzle to the space around the conical surface leading to the gate.

2. An injection molding torpedo as claimed in claim 1 wherein the melt bore has a rear portion which tapers

inwardly from a rear diameter at the rear end of the main portion of the torpedo and extends centrally to the diagonal portion of the melt bore, the rear diameter of the rear portion of the melt bore being equal in diameter to and in alignment with the melt passage through the nozzle.

3. An injection molding torpedo as claimed in claim 2 wherein the torpedo is formed of a beryllium copper alloy.
4. An injection molding torpedo as claimed in claim 2 wherein the gate extends through a cavity plate and the forward end of the nozzle is separated from the cavity plate by an insulative air space, the main portion of the torpedo having an outer surface with a mounting flange extending outwardly from the outer surface to be secured in the seat in the forward end of the nozzle between the forward facing shoulder and a hollow nozzle seal seated around the gate between the forward end of the nozzle and the cavity plate to bridge the air space and prevent leakage of melt into the air space.
5. An injection molding torpedo as claimed in claim 4 wherein the outwardly extending mounting flange is circular.



6. An injection molding torpedo as claimed in claim 5 wherein the outer surface of the main portion of the torpedo has a first cylindrical portion extending rearwardly from the mounting flange into the melt passage in the nozzle to fit in contact with the inner surface of the melt passage.
7. An injection molding torpedo as claimed in claim 6 wherein the outer surface of the main portion of the torpedo has a second cylindrical portion extending forwardly from the mounting flange to fit in contact with the surrounding nozzle seal.
8. An injection molding torpedo as claimed in claim 2 wherein the gate extends through a hollow gate insert seated in a cavity plate, the gate insert having a rear portion extending into the seat in the forward end of the nozzle, the main portion of the torpedo having an outer surface with a mounting flange extending outwardly from the outer surface to be secured in the seat in the forward end of the nozzle between the forward facing shoulder and the rear portion of the gate insert.
9. An injection molding torpedo as claimed in claim 8 wherein the outwardly extending mounting flange is

circular.

10. An injection molding torpedo as claimed in claim 9 wherein the outer surface of the main portion of the torpedo has a first cylindrical portion extending rearwardly from the mounting flange into the melt passage in the nozzle to fit in contact with the inner surface of the melt passage.

11. An injection molding torpedo as claimed in claim 10 wherein the outer surface of the main portion of the torpedo has a second cylindrical portion extending forwardly from the mounting flange to fit in contact with the surrounding gate insert.

12. An injection molding torpedo as claimed in claim 2 wherein the gate extends through a cavity plate and the forward end of the nozzle is separated from the cavity plate by an insulative air space, the torpedo being secured in the seat in the forward end of the nozzle with the rear end of the main portion of the torpedo abutting against the forward facing shoulder in the nozzle by a hollow nozzle seal seated around the gate to bridge the air space and prevent leakage of melt into the air space, the outer surface of the main portion of the torpedo having a first

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18

cylindrical portion and a second cylindrical portion, the first cylindrical portion extending forwardly from the rear end to an inwardly extending shoulder to fit in contact with the inner surface of the seat in the nozzle, the second cylindrical portion being smaller in diameter than the first cylindrical portion and extending forwardly from the inwardly extending shoulder to fit in contact with a surrounding nozzle seal.

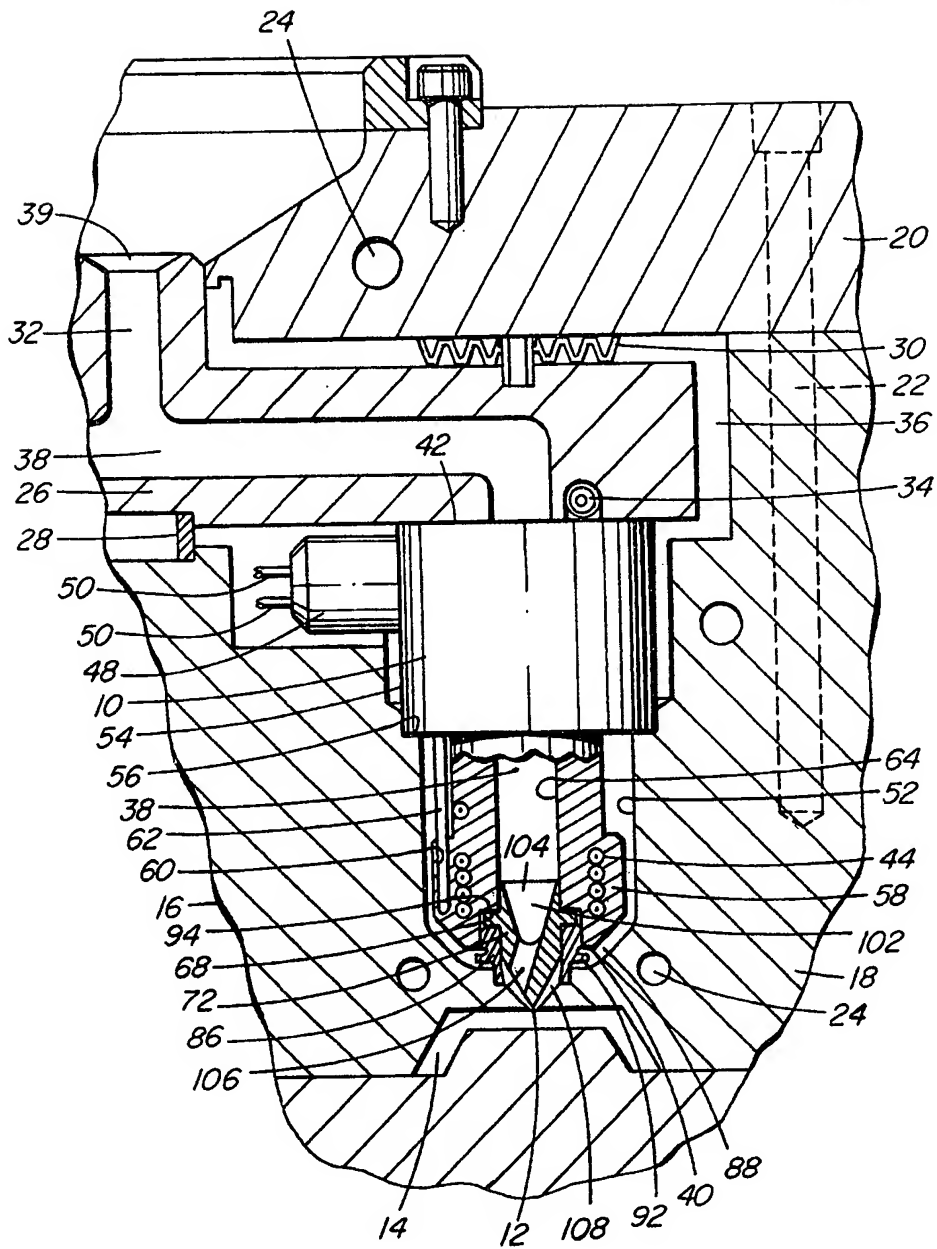


FIG. 1

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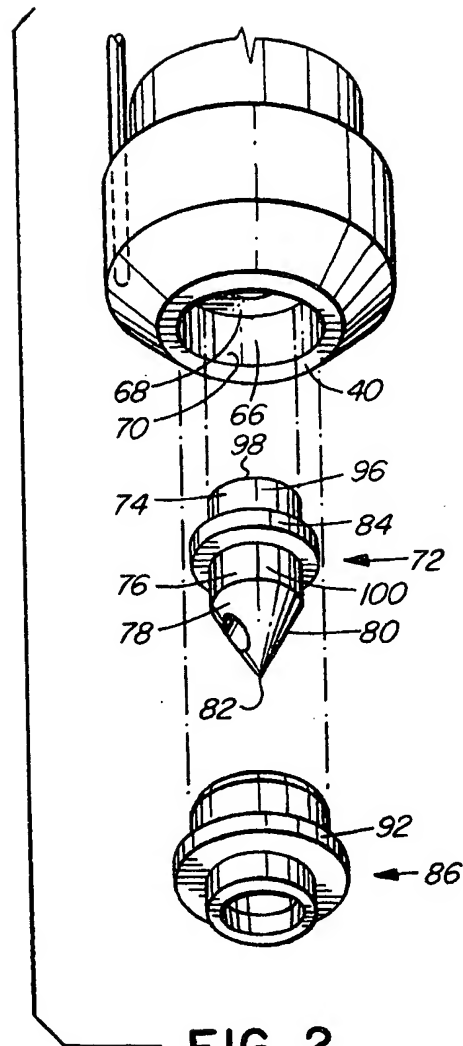


FIG. 2

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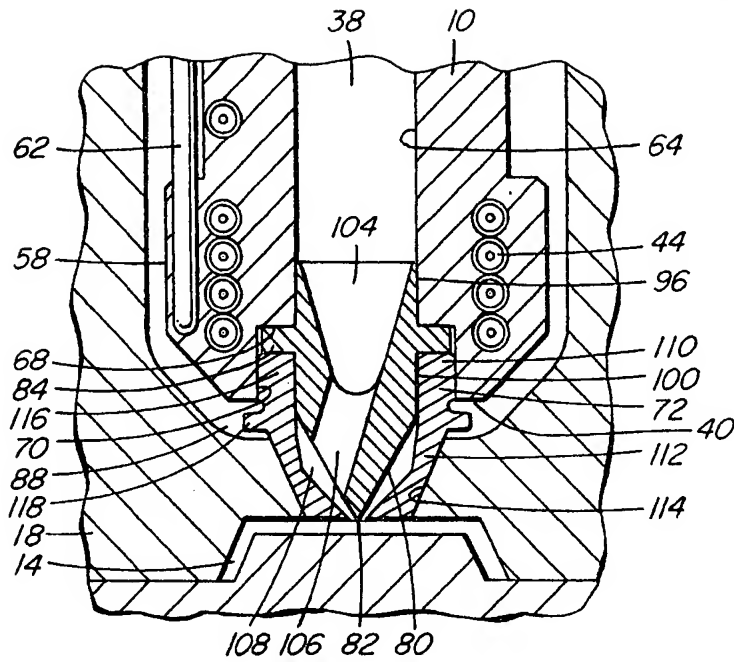


FIG. 3

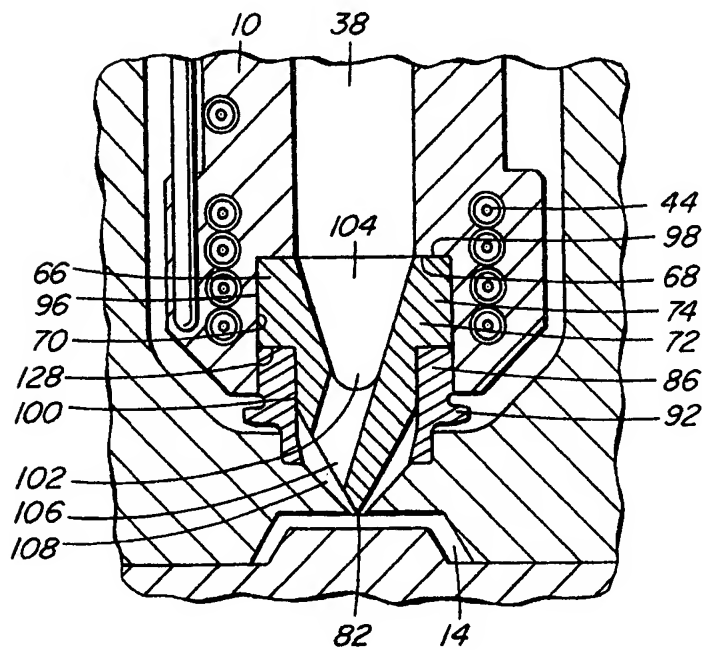


FIG. 4

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